

REMARKS

Claims 1-4, 6-10, 12-13, 15-26, 28, and 30 are pending. Claims 31 and 32 have been added. Claims 31 and 32 reinstate previously canceled Claims 14 and 29 and thus no new matter is added. The rejections of the claims are respectfully traversed in light of the amendments and following remarks, and reconsideration is requested.

Rejection Under 35 U.S.C. § 112

Claims 1-4, 6-10, 12, 13, 15-26, 28, and 30 are rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Applicant has previously stated the following:

'Table 1 . . . provides process parameter ranges . . . to form a silicon dioxide layer with a refractive index of 1.46.' (Applicant's Specification as filed, page 9, lines 7-16). 'UBUC is the deposition rate of the process with no wafer bias or clamping (unbiased, unclamped) . . . E/D ratios from about 0.0 to about -0.05 have been achieved for void-free gap filling, where the UBUC-deposited film refractive index ranges from about 1.5 to about 1.6'. (Applicant's Specification, page 8, lines 10-11 and 19-22) (emphasis added). When the deposition rate of the process is measured with no wafer bias or clamping and no gas flow change (e.g., no increased O₂ levels), the UBUC-deposited film refractive index changes as compared to the BUC-deposited film refractive index. The deposition rate of UBUC is larger than the deposition rate of BUC for the same film having the same refractive index but is NOT always larger for different films having different refractive indices. Thus, under some conditions for low deposition rates and high aspect ratio gaps, the deposition rate with bias (BUC) may be larger than the deposition rate without bias (UBUC) because the films being deposited in the two cases are of different composition (more or less silicon-richness), and therefore the E/D ratio, as defined by Applicant, may be negative. (Response to Office Action dated 9/29/03; Response to Office Action dated 4/21/03).

The Examiner stated that a "declaration from a qualified engineer is required to corroborate the Applicant statements [from the previous Response to Office Action]." (Final Office Action dated 1/12/04).

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A declaration from Larry Chen (hereinafter the "Chen Declaration") has been attached hereto as Attachment A. Please see the Chen Declaration, paragraphs 1-11, which corroborate the previous statement from Applicant.

Rejection Under 35 U.S.C. § 102(b) or
In the Alternative Under 35 U.S.C. § 103(a)

Claims 1-13, 15-28, and 30 are rejected under 35 U.S.C. § 102(b) as being anticipated by, or, in the alternative under 35 U.S.C. § 103(a) as being obvious over Papasouliotis et al. (U.S. Patent No. 6,030,881). Applicant respectfully traverses these rejections.

The Examiner Has Improperly Used Hindsight

Applicant respectfully submits that the Examiner has improperly used hindsight to anticipate or make obvious the combination taught by Applicant. Such use of hindsight is improper. As stated by the Federal Circuit:

"One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." In re Fine, 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988), *on remand*, 13 U.S.P.Q.2d 1192 (D. Conn. 1989).

Finding obviousness through hindsight (i.e., after the fact of the invention and with the teachings of the inventor available) is impermissible and refuted by the objective indicia of nonobviousness. Al-Site Corp. v. VSI Int'l, Inc., 174 F.3d 1308, 50 U.S.P.Q.2d 1161 (Fed. Cir. 1999); In re Piasecki, 745 F.2d 1468, 223 U.S.P.Q. 785 (Fed. Cir. 1984); In re Sernaker, 702 F.2d 989, 217 U.S.P.Q. 1 (Fed. Cir. 1983).

Applicant submits that this is exactly what the Examiner has done here and that the Examiner's obviousness rejection is improper as based not only on hindsight (*see* Chisum, Section 5.03[2][c]) but also on the fallacious assumption that Applicant's claimed method of utilizing a gas mixture including a percentage concentration of the oxygen-containing component and/or a ratio of the oxygen-containing component to the silicon-containing component is anticipated or obvious in view of a reference which only discloses flow rates of the components.

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For example, the Examiner states the following:

With respect to 'the oxygen-containing component is no more than 21% total concentration by volume of the gas mixture', as shown in table 1, the inert gas flow rate are in the range of 10-1000 sccm, lets consider an inert gas flow rate of 30 sccm, thus, $10 \text{ (oxygen-containing gas)} / (10 \text{ (oxygen-containing gas)} + 30 \text{ (inert gas)}) + 10 \text{ (silicon-containing gas)} = 20\%$ (no more than 21%). Therefore, Papasouliotis clearly teaches an oxygen-containing component of no more than 21% total concentration by volume of the gas mixture. (emphasis added).

Such a ratio is without support in the reference because Papasouliotis only discloses in its Tables 1-4 an extremely wide range of flow rates for oxygen and silane. No mention is made of the ratio of these two components, concentration of oxygen, optimizing composition, or even a refractive index. See the Chen Declaration, paragraphs 12-14, attached hereto as Attachment A. "A prior art suggestion for virtually endless experimentation is not a case of prima facie obviousness." In re Dow Chemical Co., 837 F.2d 469, 473, 5 U.S.P.Q.2d 1529, 1532 (Fed. Cir. 1989).

Furthermore, Papasouliotis does not disclose or suggest a negative etch/dep ratio. See the Chen Declaration, paragraph 15, attached hereto as Attachment A.

Determining the optimum ratio of the oxygen-containing component to silicon-containing component, in view of Papasouliotis, would not have been accomplished through routine experimentation but instead would have required extraordinary experimentation because non-linear extrapolation would be required to optimize the E/D ratio or composition of the reactive gas mixture within the ranges specified in Papasouliotis. See the Chen Declaration, paragraph 16, attached hereto as Attachment A.

Accordingly, Applicant submits that it would not have been obvious to determine the optimum ratio of the oxygen-containing component to silicon-containing component in the gas mixture given the disclosure of Papasouliotis. See the Chen Declaration, paragraphs 18-19, attached hereto as Attachment A.

Applicant discloses the critical nature of the reduced main sputtering component (the oxygen level) by stating that "the reduced flow rate or concentration of oxygen required for a selected flow rate or concentration of silane reduces the main sputtering component of the gas

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mixture, resulting in a reduction of sidewall redeposition, thereby helping to keep the gap open for filling.” (Specification, page 7, line 31 – page 8, line 2).

Papasouliotis Teaches Away From the Present Invention

Papasouliotis discusses deposition/etch cycling and “the need for optimizing the duration of deposition steps.” (Papasouliotis, col.6, ll.66-67). At the very least, Papasouliotis discloses cusp formation during the filling of gaps. Optimizing duration of deposition steps involved in cycling teaches away from an optimum composition of reactants for a single duration step, which may not be efficient or optimal in terms of step duration. See the Chen Declaration, paragraph 17, attached hereto as Attachment A.

The Present Invention

In contrast, amended Claim 1 recites a “method for filling a gap during integrated circuit fabrication, comprising . . . providing a gas mixture comprised of a silicon-containing component and an oxygen-containing component, wherein said oxygen-containing component is no more than 21% total concentration by volume of said gas mixture . . . and performing an HDP-CVD process using the gas mixture to fill the gap with a dielectric having a selected refractive index, wherein the ratio of the oxygen-containing component to the silicon-containing component is below about 1.2 to form the dielectric having the selected refractive index and to fill the gap without cusp formation.” Therefore, because Papasouliotis does not disclose or suggest all the limitations of Claim 1, Claim 1 is patentable over Papasouliotis.

Similarly, Claim 19 recites “providing a gas mixture comprised of silicon-containing and oxygen-containing components, wherein said oxygen-containing component is no more than 21% total concentration by volume of said gas mixture . . . and filling said gap without cusp formation by depositing said film over said gap using said gas mixture for simultaneous high density plasma chemical vapor deposition and sputter etching.” Therefore, because Papasouliotis does not disclose or suggest all the limitations of Claim 19, Claim 19 is patentable over Papasouliotis.

Similarly, Claim 30 recites “providing a gas mixture comprised of oxygen-containing and silicon-containing components, wherein said gas mixture has a ratio of said oxygen-containing component to said silicon-containing component below about 1.3, and further

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wherein said oxygen-containing component is no more than 21% total concentration by volume of said gas mixture; and filling said gap without cusp formation by using said gas mixture for simultaneous high density plasma chemical vapor deposition and sputter etching." Therefore, because Papasouliotis does not disclose or suggest all the limitations of Claim 30, Claim 30 is patentable over Papasouliotis.

Claims 2-4, 6-10, 12-13, and 15-18 are dependent on Claim 1 and contain additional limitations that further distinguish them from the cited reference. Therefore, Claims 2-4, 6-10, 12-13, and 15-18 are allowable for at least the same reasons provided above for Claim 1. Claims 20-26 and 28 are dependent on Claim 19 and contain additional limitations that further distinguish them from the cited reference. Therefore, Claims 20-26 and 28 are allowable for at least the same reasons provided above for Claim 19. For at least these reasons, Applicant respectfully requests allowance of Claims 1-4, 6-10, 12-13, 15-26, 28, and 30.

New Claims

Claims 31 and 32 have been added. Claims 31 and 32 are dependent upon Claims 1 and 19, respectively, and thus Claims 31 and 32 are patentable over the cited references for at least the same reasons provided above for Claims 1 and 19, respectively.

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CONCLUSION

For the foregoing reasons, Applicant believes pending Claims 1-4, 6-10, 12-13, 15-26, 28, and 30-32 are allowable, and a notice of allowance is respectfully requested. If the Examiner has any questions or concerns or an Advisory Action is to be issued, the Examiner is hereby requested to telephone Applicant's Attorney at (949) 752-7040.

Certificate of Facsimile Transmission

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office on the date shown below.

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May 12, 2004
Date of Signature

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